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Seventh United Nations Regional Cartographic Conference for the Americas
New York, 22-26 January 2001
Item 7 (c) of the provisional agenda*
Reports on achievements in surveying, mapping and charting in addressing national, subregional, regional and global issues, including applications

The Malaysian digital cadastral database

Submitted by the Federation of Land Surveying and Geomatics of the Association of South-East Asian Nations**

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** Prepared by Abdul Majid bin Mohamed, President, The Federation of Land Surveying and Geomatics of the Association of South-East Asian Nations.

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THE MALAYSIAN DIGITAL CADASTRE DATABASE

Issues and Strategies

By

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Licensed Land Surveyor/ ESRI South Asia

Department of Survey and Mapping Malaysia (DSMM)

One of the oldest govt depts in Malaysia (c. 1885)

Modernisation Strategy: (wef 1986)

~ use of total stations + data loggers in field

~ computerise data processing in office

~ role of the private sector

~ revise SOP / Land Surveyors Act / Survey Regulations, etc

~ consultancy with consortium of international experts

ECONEXPERT

SPDK / Cadastral Database Management System

~ implemented wef 1999 to date

Problem statement

≈ 6 Million parcels

≈ 3.5 Million Qualified Titles

≈ 500,000 Certified Plans

≈10 Million records

=> of various scales, accuracies & epoch

Problem statement

- 12 regional offices
- Cassini Soldner, each with own origin
- Geodetic network }
- GPS network }

Rectified Skew Orthomorphic Projection nationwide

ECONF9188C7

The CDMS Project

- Implemented in 12 States
  - » *At Headquarters & district levels*
- Pilot at KL & Selangor offices
- RM 50 Million budget
- Final acceptance January 2000
  - *– 12 months implementation period*

ECONES/BP7

The Project Components

- Quality Assurance System
- Digital Imaging Management System
- Improved Counter Service
- Remote & Internet access ~ e-commerce
- Outsource to the private sector

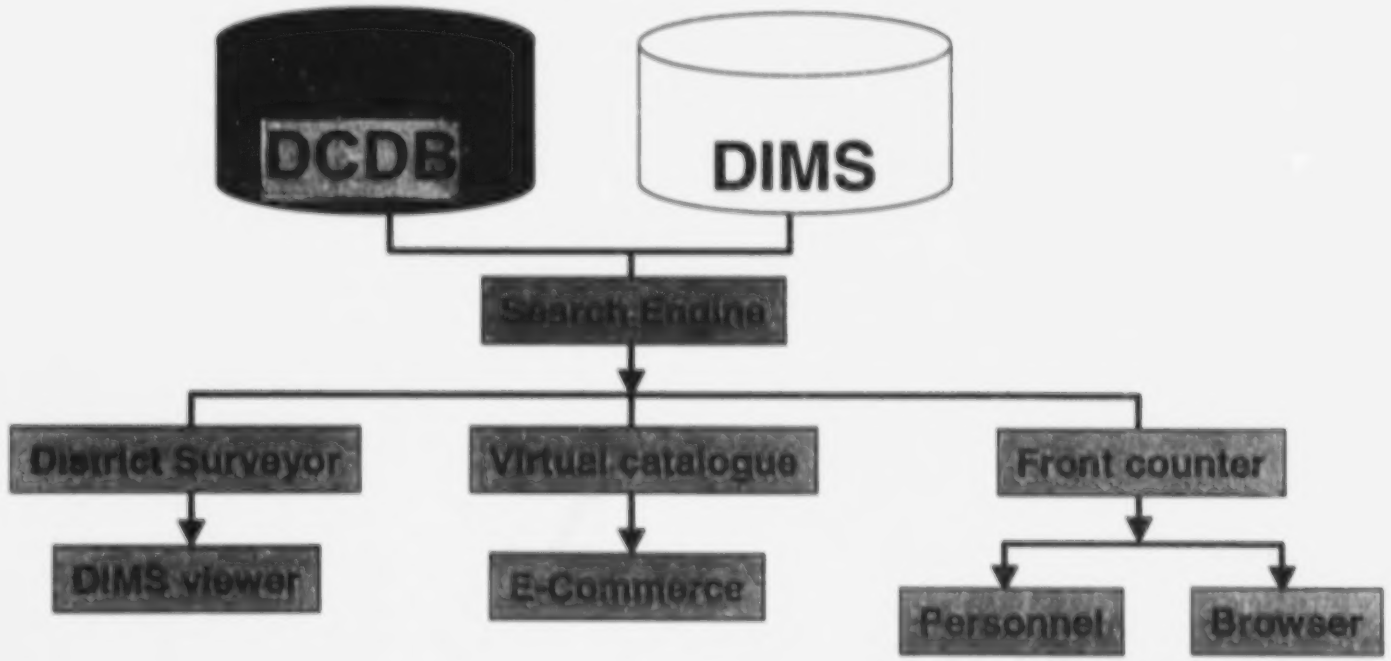
Components of CDMS

- Hardware
  - ❖ Database/Web Server , Interactive Graphic Workstation, Desktop PC, Plotter, Printer, Scanner, Storage Media (SCSI Disk, Disk Array, CD Writer) and Networking & Internet Access

- Software
  - ❖ Open System, Networking Software, Application Software for DIMS, Counter Service Software, Microsoft OA Software for PC, Application Software for QAS, CPS software, GIS software/RDBMS* Software and Web Software

** ArcInfo, ArcView,MapObjects, ArcSDE*

ECONF9JBP7



Range of products
- Maps
- Certified plans
- Standard sheets
- Lot information
- Search
- Technical information
- User-defined

Format
- Hardcopy
  - A4 – A0
- Softcopy
  - Tiff
  - DXF
  - Shapefiles

Media
- Paper
- 3.5" floppy
- 5.23" CDRW

Delivery
- Download, ftp
- Postal, courier

Databases being created in the Dept:

1. Digital Cadastral Data Base (DCDB):

~ at the State level (12 states)

2. CAMS data base (Digital Topographic Data Base) :

~ at the national level

ACCURACY OF SPATIAL DATA BASES

- DATA QUALITY

  - " fitness for use ": reliable, accurate, current, relevant, complete, timeliness, precise....
  - conveniently handled, adequately protected, metadata

  α *Accuracy, Precision, Error*

ACCURACY:

~ level of accuracy α objectives of application

PRECISION:

~ hardware dependent

α scale, unit of measurement, objectives of application

ERROR:

~ gross, systematic or random errors

UNCERTAINTY:

~ " lack of total confidence in use of the data ": incomplete knowledge of data

SOURCES OF ERRORS (in geographic data) :

- INHERENT ERRORS:

~ occur naturally in geographic data no matter what instruments or procedures used for data acquisition, management & application

- OPERATIONAL ERRORS:

~ " processing errors " α imperfections in instruments and methods used for data acquisition, management & application

Errors occur all the time & may be carried over to subsequent stages of processing !

COMPONENTS OF GEOGRAPHIC DATA QUALITY *

1. Lineage

2. Positional accuracy

3. Attribute accuracy

4. Logical consistency

5. Completeness

6.Temporal accuracy

7. Semantic accuracy

*** US National Committee for Digital Cartographic Data Standards , International Cartographic Association.**

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ASSESSMENT OF DATA QUALITY

1. EVALUATION OF POSITIONAL ACCURACY

   Planimetric accuracy

   Height accuracy

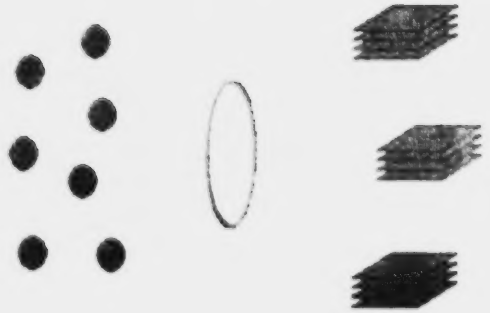
2. EVALUATION OF ATTRIBUTE ACCURACY

   Compare sample data with reference data via field verification, sources of data of higher accuracy

Data Catalogue

Data Portal

- Know where you have data
- Know what data you have
- Get access to you data
- Make your data work



"Fitness for Use"

- Digital data can be wrong!
- Database is only as good as the lowest quality data layer.
- Mistakes can have deadly consequences.
- Data rules and education of the users is crucial.

SPATIAL DATA INTEGRATION ISSUES

DCDB: high internal & relative acuracy

1:80K 1st Class, 1:40K 2nd Class svys

VB interface: GEN + ArcView shape files

CAMS: mapping data, multiple layers

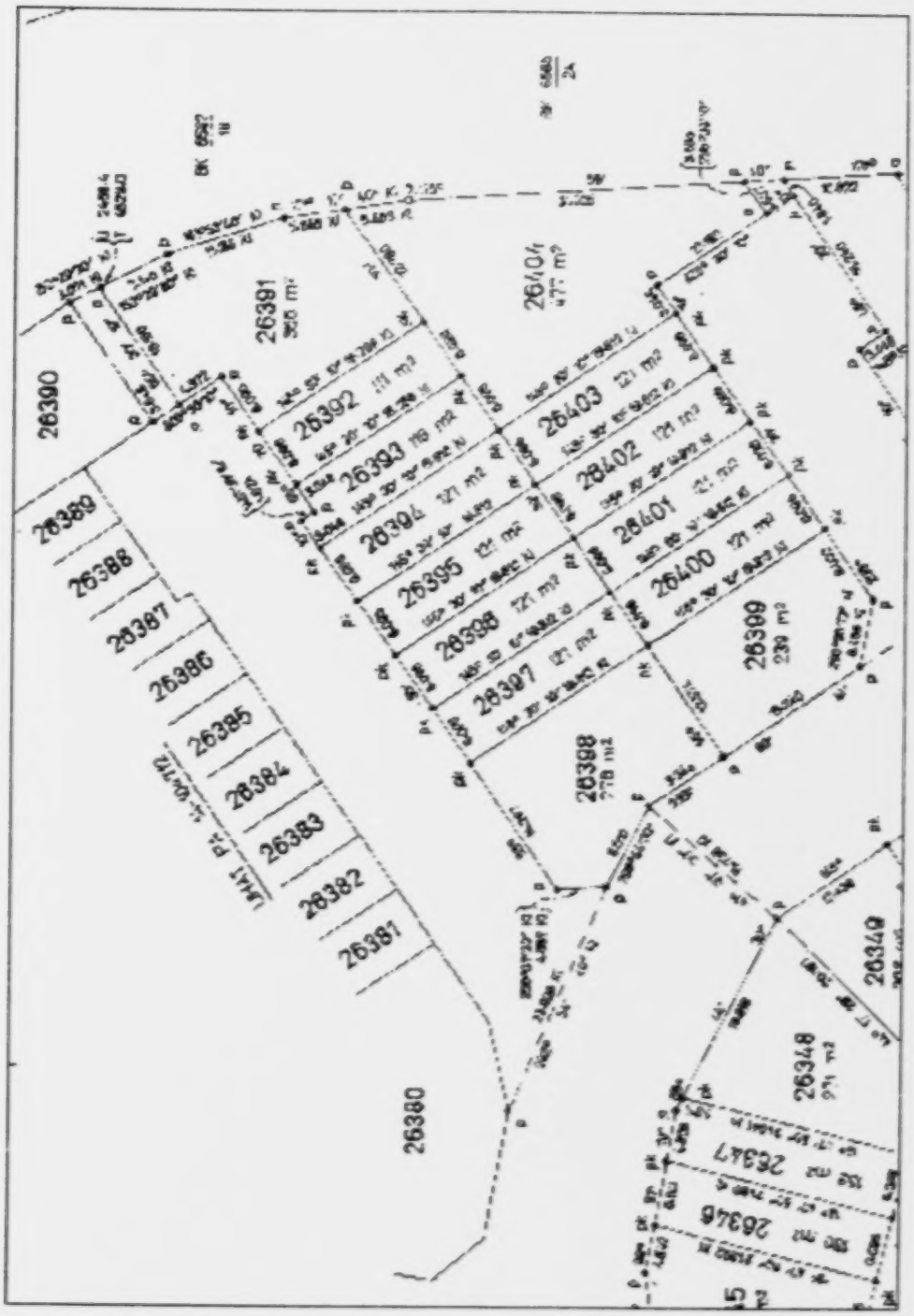
1:40K → 1: 5K

lower internal acc.

good absolute acc.

CAD - not GIS ready

SPATIAL DATA INTEGRATION ISSUES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SAMPLE OF CAMS DATA

- Prepared in CAMS format
- Data in Layer form
- Map Scale 1:25,000

Spatial Data Integration Issues..

- Referencing:
  - Cadastre : Cassini
  - CAMS : RSO (Oblique Mercator)
  - CCS : geocentric, WGS 84 ~ ITRF + velocities

- CAMS: not comparable with DCDB map scales, geometric acc, data acquisition strategy, etc

Strategies & future direction…

- Strategy for integration:
  - Fully GIS ready db within a small test area
  - CAMS map with DCDB map overlay
  - Appropriate scale for integration
  - New product (orthophoto imageries) line for CAMS?

Strategies & future directions…

- The SPDK / CDMS project:

  Towards a Cadastral Vision

- National Cadastral Data Infrastructure:

  -a cadastral toolkit at the state level

  - ability to integrate with other databases

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Strategies and future directions…

- Institutional arrangements:

  Political acceptance

  Stakeholders:common vision

  Common infrastructure

- Sustainability:

  RM50 Million + RM 80 M allocation 8MDP (2001-6)

  Geo-processing staff: in-house + outsource

Strategies and future directions....

- database development

  Integrated, holistic approach : in-house + outsourcing strategy

  LONG TERM VISION

- manpower related issues:

  In house core group

  User / developer close interaction + learning

National & International recognition...

- Finalist in Prime Minister's Quality Award
- Winner of PIKOM Malaysia's Innovation award (1999)
- ESRI Special Achievement in GIS (SAG) Award July 2000

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Spatial standards as basis for a sustainable geospatial data infrastructure

(Submitted by Technical Committee 211 of the International Organization for Standardization)**

* E/CONF.93/1.

** Prepared by Olaf Ostensen, Chairman of Technical Committee 211 of the International Organization for Standardization, Chairman, Joint Steering Group on Spatial Standardization and Related Interoperability.

00-80699 (E) 100101

Spatial standards as basis for a sustainable geospatial data infrastructure

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Introduction

At the United Nations Conference on Environment and Development in Rio de Janeiro in 1992, a major resolution was passed to focus on reversing the impacts caused by environmental deterioration. The Agenda 21 resolution establishes measures to address deforestation, pollution, depletion of fish stocks, and management of toxic wastes to name a few. The importance of geographic information to support decision-making and management of these growing national, regional, and global issues was cited as critical at the 1992 Rio Summit, and by a special session of the United Nations General Assembly assembled in 1997 to appraise the implementation of the Agenda 21.

Geographic information is vital to make sound decisions at the local, regional, and global levels. Crime management, business development, flood mitigation, environmental restoration, community land use assessments and disaster recovery are just a few examples of areas in which decision-makers are benefiting from geographic information, together with the associated infrastructures (i.e. Spatial Data Infrastructure or SDI) that support information discovery, access, and use of this information in the decision-making process.

The disciplines of cartography and geography, in response to technological innovations, have individually and collectively undergone significant changes during the past half-century. The 1950's witnessed the quantification of geography followed by the introduction of computers and modeling during the 1960's. The application of computer technology to cartography during the 1970's gave rise to automated/computer-assisted cartography, along with the adaptation of the mathematics of topology to computer cartography / geography around 1975 that lead to the emergence of geographic information systems (GIS). From 1985 to1995 saw the widespread development, use,

and acceptance of GIS technology. During the period from 1995 to 2000, spatially enabled enterprise databases and the deployment of geographic information on the Internet rapidly positioned a new location-based technology as part of generic information technology. Leveraging wireless and mobile applications, location-based products, services, and solutions are now initiating the new millennium with the promise of an increasing need for locational functionality and geographic information via the Internet by not just the geographic community, but the world at large.

The era of modern of geographic standardization spanned the decade from the early 1980's to the early 1990's. Internationally, initial standardization efforts within cartography and geography were slow and arduous. National and international organizations were busy developing standards for the transfer / exchange of geographic data between computers systems. The technical development of such standards were limited to few national and regional user communities. There were no standards that had broad international support. By 1995, ISO/TC 211 and the Open GIS Consortium (OGC) emerged with GIS standards becoming a highly visible and prominent part of the international geographic agenda. The value of these initial international standardization efforts was to gain the international recognition and acceptance by the cartographic and geographic communities of the need and value of geographic standardization.

Spatial Data Infrastructure

Different countries and regions have dissimilar definitions of the notion spatial data infrastructure. This reflects differences in tradition, technology, maturity and ambitions. Even highly industrialized countries may fail to recognize the needs for an ambitious spatial data infrastructure to support the development of the information society and enterprise activities associated with it. There is a clear need for stakeholders to take leadership in this development – no infrastructure is built by accident.

Fortunately, important stakeholders are taking the responsibility. The Global Spatial Data Infrastructure is exactly an initiative that identifies many of the requirements of a SDI, and has the ambition to aid countries and regions in concrete actions to achieve the SDI. This is for instance done through the development of "The SDI Cookbook".

In this Cookbook we find the following definition:

> The term "Spatial Data Infrastructure" (SDI) is often used to denote the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. The SDI provides a basis for spatial data discovery, evaluation, and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and by citizens in general.
>
> .....
>
> An SDI must be more than a single data set or database; *an SDI includes geographic data and attributes, sufficient documentation (metadata), a means to discover, visualize, and evaluate the data (catalogues and Web mapping), and some method to provide access to the geographic data. Beyond this are additional services or software to support applications of the data. To make an SDI functional, it must also include the organizational agreements needed to coordinate and administer it on a local, regional, national, and or trans-national scale.*

Thus we see that several requirements must be fulfilled before we can talk about an SDI. E.g. data is not enough – neither as a single dataset or a database, nor as a set of datasets or databases. Without the possibility to discover data and evaluate data through some mechanism like a metadata catalogue, and ways of accessing data through Internet (e.g. web), it is no *spatial data infrastructure*. It is in these respects that so many still fails to fulfill the requirements. Data may exist – even high quality and large scale data – but it is very difficult for the public to obtain access. Both technology, authorization and pricing may constitute – together, or each – insurmountable obstacles. Concerning technology, the notion of interoperability is a key concern.

Interoperability is the ability of a system or system component to provide information sharing and inter-application co-operative process control. Standardization of geographic information can best be served by a set of standards that integrates a detailed description of geographic information concepts with the concepts of information technology. A goal of the ISO 19100 series standardization effort is to facilitate interoperability of geographic information systems, including interoperability in distributed computing

environments. Interoperability provides the freedom to mix and match information system components without compromising overall success. Interoperability refers to the ability to:

a) Find information and processing tools, when they are needed, independent of physical location.

b) Understand and employ the discovered information and tools, no matter what platform supports them, whether local or remote.

c) Evolve a processing environment for commercial use without being constrained to a single vendor's offerings.

d) Build upon the information and processing infrastructures of others in order to serve niche markets, without fear of being stranded when the supporting infrastructure matures and evolves.

e) Participate in a healthy marketplace, where goods and services are responsive to the needs of consumers and where commodity channels are opened as the market expands sufficiently to support them.

Although not explicitly stated, it is clear that *standards* is a fundamental requirement in both obtaining interoperability and, more general, to build the SDI. A previous definition by Prof. David Rhind is making this explicit:

> "A Global Geospatial Data Infrastructure encompasses the politics, organizational remits, data, technologies, standards, delivery mechanisms and financial and human resources necessary to ensure that those working at the global or regional scale are not impeded in meeting their objectives"

Standardization

Standards are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose. The International Organization for Standardization (ISO) is a worldwide federation of national standards bodies from some 130 countries, one from each country.

The existence of non-harmonized standards for similar technologies in different countries or regions can contribute to so-called "technical barriers to trade". Export-minded industries have long sensed the need to agree on world standards to help

rationalize the international trading process. This was the origin of the establishment of ISO.

Work in the fields of environmental management and geographic information are among the newer activities, taken up in the mid 1990's.

International standardization is well-established for many technologies in such diverse fields as information processing and communications, textiles, packaging, distribution of goods, energy production and utilization, shipbuilding, banking and financial services. It will continue to grow in importance for all sectors of industrial activity for the foreseeable future.

Development agencies are increasingly recognizing that a standardization infrastructure is a basic condition for the success of economic policies aimed at achieving sustainable development. Creating such an infrastructure in developing countries is essential for improving productivity, market competitiveness, and export capability.

ISO and the market

The World Trade Organization (WTO) is the international organization dealing with the global rules of trade between nations. Its main function is to ensure that trade flows as smoothly, predictably and freely as possible.

ISO – together with IEC (International Electrotechnical Commission) and ITU (International Telecommunication Union) has built a strategic partnership with WTO. The political agreements reached within the framework of WTO require underpinning by technical agreements. ISO, IEC and ITU, as the three principal organizations in international standardization, have the complementary scopes, the framework, the expertise and the experience to provide this technical support for the growth of the global market.

The agreement with WTO recognizes the important contribution that international standards and conformity assessment systems can make to improving efficiency of production and facilitating international trade. Where international standards exist or their completion is imminent, therefore, the code of Good Practice says that

standardizing bodies should use them, or the relevant parts of hem, as a basis for standards they develop. It also aims at the harmonization of standards on as wide a basis as possible, encouraging all standardizing bodies to play as full a part as resources allow in the preparation of international standards by the relevant international body, including the ISO and IEC.

Geographic information market and standards

All businesses that produce, distribute, or utilize spatial information alone or in conjunction with non-spatial information will benefit from spatial standards. Environments supported include geographic information, decision support, data mining, data warehousing and modeling and simulation. Application areas include but are not limited to automated mapping, geo-engineering, computer aided drafting and design, entertainment, modeling, and simulation. These span the planning, design, construction, operation, and maintenance of facilities and their supporting infrastructure such as communications, transportation, and utilities.

A common way to describe the market is by dividing it into three segments: the traditional geographic information systems (GIS) market, business support systems (BSS), and personal productivity (PP). A description can be given as:

- GIS:
  - Spatial information contributes the most value
  - Traditional market for spatial technology
- BSS:
  - Spatial information does not contribute the most value
  - Spatial technology embedded in business applications
- PP:
  - Users want to communicate with maps/ geographic information
  - Follows Office Suite marketA new emerging market is location based mobile services (LBMS).

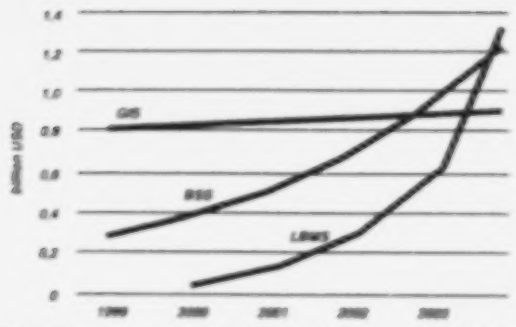

Fig. Revenues in the traditional GIS market (GIS), for business support systems (BSS) and the emerging technology, location based mobile services (LBMS) according to IDC.

There are many places in the marketplace that will benefit significantly from interoperable access to spatial information and services. Industry sectors include such areas as the travel and tourism industries, the mapping and routing industries, communications, utilities, transportation, national defense, agriculture, disaster management and public safety, location/mobile services, inventory management, real and synthetic environmental modeling and gaming, and the emerging needs of electronic commerce for spatial information.

Achieving more interoperability requires proactive coordination of spatial standards at both the abstract and implementation levels of detail. Proactive cooperation between spatial standards activities should also help to utilize, more efficiently, available resources by minimizing technical overlap, where appropriate. Such coordination and cooperation should lead to more market relevant spatial standards and could serve as a useful roadmap for all interested parties.

The increasing recognition for the value of spatial data and geographic information has spawned the entry of new players into the spatial standardization arena, both from within ISO and externally. This has resulted in the formation of a Joint Steering Group on Spatial Standardization and Related Interoperability, chaired by the ISO/TC 211 Chairman. Consequently, a new agenda is emerging for international spatial standardization that includes traditional and new innovative applications across a spectrum of disciplines. For ISO/TC 211, these developments are resulting in new strategic directions.

Current members :

ISO Central Secretariat

ISO/TC 211

OGC

SEDRIS

The following organizations have also been invited and/or participated in the process :

DGIWG

IETF

ISO/TC 184 /SC 4

ISO/TC 204

ISO/IEC JTC 1

ISO/IEC JTC 1/SC 24

ISO/IEC JTC 1/SC 31

ISO/IEC JTC 1/SC 32

OMG

POSC

SAE International

SISO

W3C

WAP forum

Scope of the ISO/TC 211

The formal scope of ISO/TC 211 Geographic information/Geomatics is as follows:

> Standardization in the field of digital geographic information. This work aims to establish a structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the Earth. These standards may specify, for geographic information, methods, tools and services for data management (including definition and description), acquiring, processing, analyzing, accessing, presenting and transferring such data in digital/electronic form between different users, systems and locations. The work shall link to appropriate standards for information technology and data where possible, and provide a framework for the development of sector-specific applications using geographic data.

Beyond the needs within traditional applications of digital geographic information, there is a growing recognition among users of information technology that indexing by location is a fundamental way to organize and to use digital data. Increasingly, digital data from a wide variety of sources is being referenced to locations for use in a diversity of applications. Consequently, there is an increasing need for standardization of geographic information and services for processing this information. To meet this need, the ISO 19100 series (i.e. the standards developed by ISO/TC 211) standardizes relevant aspects of the description and management of geographic information and geographic information services. This standardization will:

a) increase the understanding and usage of geographic information;

b) increase the availability, access, integration, and sharing of geographic information;

c) promote the efficient, effective, and economic use of digital geographic information and associated hardware and software systems;

d) contribute to a unified approach to addressing global ecological and humanitarian problems.

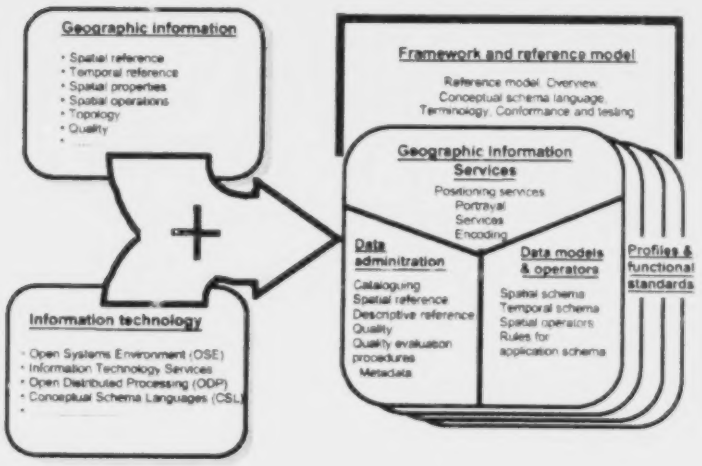

Fig. "Map" of the ISO/TC 211 approach to standardization

The ultimate benefits of standardization are based on the use of widely recognized and accepted international voluntary standards developed to the highest technical level by an open consensus process that includes all those affected. Beyond standardization of traditional geographic functionality: innovative, new, and unknown technology and application domains present challenges transcending the established process of geographic standardization. Previously, standardization was a process for recognizing and

codifying the status quo of technology. Standardization is now beginning to define the requirements and implementation of new technology.

The implied mandate for ISO/TC 211 is to develop an integrated set of standards for geographic information. Equally important, if not more so, is the unstated strategic direction for the international deployment of such standards. Accordingly, the strategic directions for ISO/TC 211 can be viewed in terms of development, deployment, and the underlying coordination/consensus process that integrates both these phases for successful standardization.

For development, the major issues include: standards technical development, organizations developing geographic or related standards, priorities of standards, standards and interoperability testing, and speed of developing technical specifications. For deployment, the key issues are: implementation of standards, standards education / training, and user communities supporting ISO/TC 211 standards.

Inherent and pervasive through standards development, deployment, and their coordination/consensus process are considerations for the implementors and users of geographic standards. Such as data transfer standards that are implemented by vendors or data cataloguing standards implemented by data producers, or metadata standards implemented by vendors, data producers, and general users of geographic information. Implementors and user requirements need to be considered in conjunction with the standards development, deployment, the process of integrating such requirements.

Traditionally, geographic information was produced and used by the geographic community. Increasingly, geographic information is being created and used by everyone else, especially, in the business community. Hence, the once all important technical issues for experts are now being subordinated to the business issues confronting government and commercial organizations. Previously, the cost of standardization was minimal because of the number of users and requirements. Because geographic information has transitioned, in many countries, from being the essence of national mapping organizations to being the common commodity of consumers in the electronic/Internet/wireless communities – the diverse requirements, costs, and complexity for geographic standardization has increased dramatically.

- ISO 19101 - Reference model
- ISO 19102 - Overview
- ISO 19103 - Conceptual schema language
- ISO 19104 - Terminology
- ISO 19105 - Conformance and testing
- ISO 19106 - Profiles
- ISO 19107 - Spatial schema
- ISO 19108 - Temporal schema
- ISO 19109 - Rules for application schema
- ISO 19110 - Feature cataloguing methodology
- ISO 19111 - Spatial referencing by coordinates
- ISO 19112 - Spatial referencing by geographic identifiers
- ISO 19113 - Quality principles
- ISO 19114 - Quality evaluation procedures
- ISO 19115 - Metadata
- ISO 19116 - Positioning services
- ISO 19117 - Portrayal
- ISO 19118 - Encoding
- ISO 19119 - Services
- ISO/TR 19120 - Functional standards + new revision started
- ISO/TR 19121 Imagery and gridded data
- ISO/TR 19122 - Qualifications and certification of personnel
- ISO 19123 - Schema for coverage geometry and functions
- ISO 19124 - Imagery and gridded data components
- ISO 19125-1 - Simple feature access – Common architecture
- ISO 19125-2 - SFA - SQL option
- ISO 19125-3 - SFA – COM/OLE
- ISO 19126 - Profile - FACC Data Dictionary
- ISO 19127 - Geodetic codes and parameters
- ISO 19128 – Web map server interface

Table. The current ISO/TC 211 work programme

ISO/TC 211 is currently accomplishing a very challenging task in developing – mostly in parallel – the set of standards as illustrated in the table above. The first standard is approved for publication and several more will be available during 2001.

Concluding remarks

The goal of international standardization in the field of geographic information is to develop a family of standards that will:

- support the understanding and usage of geographic information
- increase the availability, access, integration, and sharing of geographic information, enable inter-operability of geospatially enabled computer systems
- and ease the establishment of geospatial infrastructures on local, regional and global level.

and thus contribute to a unified approach to addressing global ecological and humanitarian problems and a sustainable geospatial data infrastructure!

A large set of organizations will cooperate in achieving this.

References

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Land administration, spatial data infrastructures and sustainable development

Submitted by the Secretariat**

* E/CONF.93/1

** Prepared by Ian Williamson, Director, United Nations Liaison, International Federation of Surveyors, Professor of Surveying and Land Information, Department of Geomatics, University of Melbourne, Australia

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Background Paper for the United Nations
Seventh Regional Cartographic Conference for the Americas
22-26 January, 2001, New York

LAND ADMINISTRATION, SPATIAL DATA INFRASTRUCTURES AND SUSTAINABLE DEVELOPMENT

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ABSTRACT

Current land administration systems are the product of 19th century economic and land market paradigms and have failed to properly support sustainable development. The need for urgent reform is accepted, but the way forward unclear in many jurisdictions. This paper discusses current international initiatives and research to develop a new land administration vision to promote sustainable development.

Within this context, this paper describes the changing humankind to land relationship, identifies some of the growing environmental pressures facing modern society and the need for sustainable development, explores the evolving role of land administration in society and highlights the need for land administration systems to play a more proactive role in supporting sustainable development objectives. The process to re-engineer land administrations is reviewed. The paper proposes that spatial data infrastructures should be a key component of any re-engineered land administration systems that wish to support sustainable development. The paper then highlights the development and importance of a national land administration vision and strategy.

The paper describes the recent United Nations – International Federation of Surveyors Declaration on Land Administration for Sustainable Development as an important initiative in better understanding the relationship between land administration and sustainable development.

The paper concludes with a number of recommendations relating to the role and linkages between land administration, SDIs and sustainable development, for consideration by the Seventh United Nations Regional Cartographic Conference for the Americas.

INTRODUCTION

Land, and the interaction of human societies with it, result in many economic, social, political and environmental concerns. The dialogue between these competing and overlapping concerns requires a land administration system that is able to support the ever changing relationship between humankind and land, to facilitate complex decision making and to support the implementation of those decisions. Therefore, appropriate and effective land administration is of crucial importance for sustainable development.

In recent decades the global drivers of sustainable development, environmental sustainability, globalisation, urbanisation, economic reform and technology have influenced the development of the different land administration polices and models adopted by governments. These models and concepts can only be developed with a clear understanding of current land administration issues and trends. By its very nature, land administration focuses on land tenure and cadastral (land parcel related) issues. The land administration perspective includes understanding the changing humankind-land relationship, private and public property rights, land tenure issues such as native title, institutional and administrative issues such as the relationship between infrastructures and the business systems they support, the design and role of spatial data infrastructures (SDI), and technical issues such as those concerned with the use of the World Wide Web (WWW) and other communication technologies.

Land administration trends have followed a course mapped by dynamic changes in societies and their increasingly complex attitudes to land as personal security, wealth, as an expendable

commodity, as a scarce community resource, in support of environmental survival and sustainable development (Ting and Williamson 1999).

Within this context, this paper describes the changing humankind to land relationship, identifies some of the growing environmental pressures facing modern society and the need for sustainable development, explores the evolving role of land administration in society and highlights the need for land administration systems to play a more proactive role in supporting sustainable development objectives. The process to re-engineer land administration systems is reviewed. The paper highlights the development of a national land administration vision and strategy and discusses some SDI issues which should be considered when re-engineering land administration systems.

The paper concludes by making a number of recommendations on the importance and linkages between land administration, spatial data infrastructures and sustainable development, for consideration by the Seventh United Nations Regional Cartographic Conference for the Americas.

THE CHANGING HUMANKIND TO LAND RELATIONSHIP

The relationship between humankind and land in almost every society is dynamic, albeit the relationship varies for almost every situation (Ting and Williamson, 1999). This continual change can be seen in the context of "Western" land tenure systems in Figure 1.

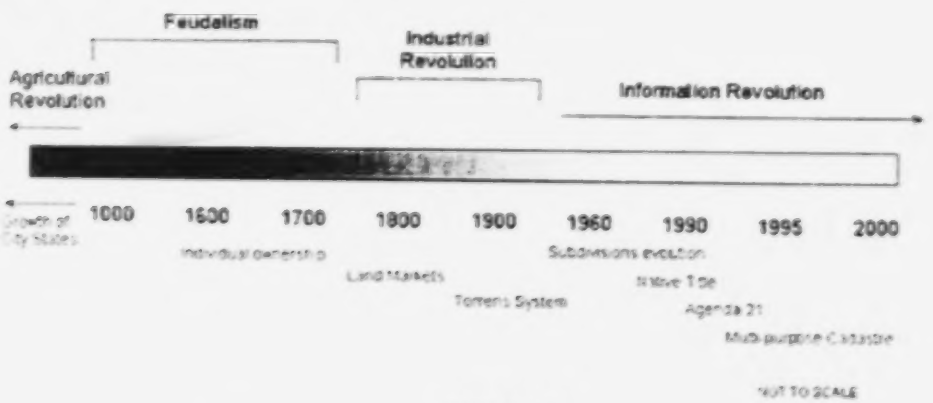

FIGURE 1
A Western view of the changing humankind to land relationship
(Ting and Williamson, 1999)

A review of the dynamic humankind-land relationship (Ting and Williamson, 1999) shows that in a western context, it may be classified into four broad phases.

- Human settlement during the agricultural revolution through to the feudal system, which tied human beings to land in a physical way. Land was the primary symbol and source of wealth. In this phase, the cadastral system's role was to publicly record ownership as well as for fiscal purposes.

- The Industrial Revolution began a process of breaking that strong physical tie to land by turning land into more of a commodity, albeit the most valuable commodity and primary source of capital. In many western countries, the mobility of people and the rise of capital and commodification of land brought by the Industrial Revolution, gave birth to major legal and institutional changes. This environment gave birth to land markets and so cadastre took on another focus – a tool to support land transfer and land markets. The Torrens system of land titling is a good example of the institutional and legal responses to the burgeoning of land markets in the 19th Century.

- The post-World War II reconstruction and the population boom saw an awareness of land as a scarce resource that was not sufficient for the needs of a growing world population which was becoming more mobile. With this came an interest in planning, particularly urban and regional planning. Planning in turn created another application for the cadastre.

- The 1980s have seen a different twist in the concern for the scarcity of land. The focus has turned to wider issues of environmental degradation and sustainable development, as well as social equity. All of these issues have the probable effect of tempering short-term economic imperatives. Planning issues have widened to include more community interests and deepened to address more detailed issues of land use. This has created a growing need for more complex information about land and land use. The impact of these has been manifested in the desire for multi-purpose cadastres.

The land administration response to these changing phases is shown diagrammatically in Figure 2.

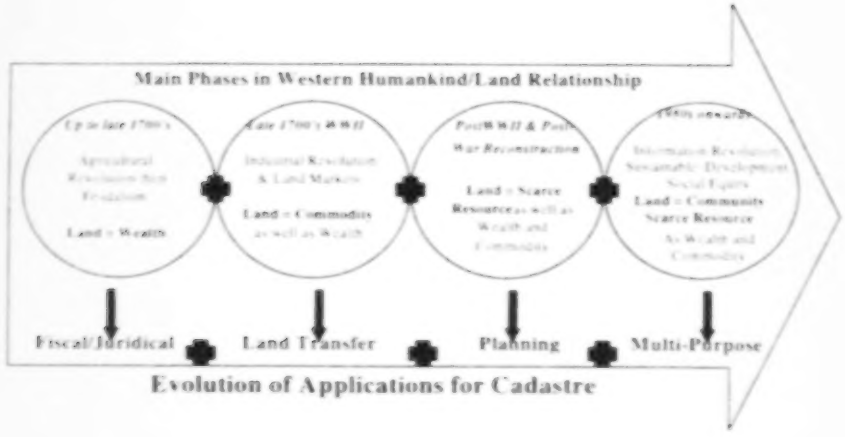
Main Phases in Western Humankind/Land Relationship
Land = Wealth
Land = Commodity as well as Wealth
Land = Scarce Resource as well as Wealth and Commodity
Land = Community Scarce Resource as Wealth and Commodity
Fiscal/Juridical
Land Transfer
Planning
Multi-Purpose
Evolution of Applications for Cadastre

FIGURE 2
(Ting and Williamson, 1999)

Many developed countries are in the course of making the transition from the third to the fourth phases, while many developing countries are experiencing change across all four phases. Apart from examining local, state or national structures and their associated legal, institutional, economic and social frameworks, the current era requires that nations take into consideration these global drivers.

However for most countries, land administration reform is not that simple. On the one hand the relationship of humankind to land varies across a country from urban areas, with active land markets and often informal settlements, to both titled and non titled rural areas, to areas under traditional or indigenous rights with no land market, to areas under a range of different common property tenures. This then requires different land administration responses for these respective areas (Williamson, 2000). This is further complicated since countries are at different stages of development thereby affecting the choice of the land administration response. As mentioned above neither of these situations is static, neither the different humankind to land relationships nor the stage of development of the country. So the response proposed today based on current requirements might not be appropriate for tomorrow since the requirements may be different.

In summary the key outcomes from this analysis are that the relationship of humankind to land in almost all societies is dynamic being influenced by these global drivers, and that this changing relationship results in a changing land administration response over time.

THE ENVIRONMENTAL PRESSURES

The above analysis also shows that during the last twenty years there has been a trend towards tempering raw economic priorities with society's growing awareness and preparedness on environmental and social (e.g. indigenous rights and issues concerned with women's access to land) priorities. Undoubtedly, the sharpest dialogue during this period is between the economic and environmental forces. People are both the problem and the solution.

In 1992, the historic UN conference in Rio de Janeiro (The Earth Summit) produced Agenda 21, which stated in its preamble that:

> "Humanity stands at a defining moment in history. We are confronted with a perpetuation of disparities between and within nations, a worsening of poverty, hunger, ill health and illiteracy, and the continuing deterioration of the ecosystems on which we depend for our well being. However, integration of environment and development concerns and greater attention to them will lead to the fulfillment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer, more prosperous future. No nation can achieve this on its own; but together we can - in a global partnership for sustainable development."

The world's population now stands at 6 billion. According to the United Nations Environment Program's (UNEP) 1999 statistics (United Nations 1999):

- half of the world's population currently lives in urban areas and within thirty years this will increase to two-thirds;
- by 2025, two-thirds of the world's population will live in water-stressed conditions – with irrigated agriculture accounting for 70-75% of fresh water use;
- human-induced degradation of the soil has already affected 20% of the world's drylands and puts the livelihoods of one billion people at risk.

- more than half of the world's population live within 60km of the shoreline. One-third of those coastlines are already damaged by population stress and infrastructure (or lack thereof);
- global emissions of CO^2 reached a new high of nearly 23.9 billion tonnes in 1996 - nearly four times the 1950 total;
- in 1995, 25 per cent of the world's 4,630 mammal species and 11 per cent of the 9,675 bird species were at significant risk of extinction; and
- average global per capita income has now passed US$5,000 a year but more than 1 billion people still live on less than US$1 per day.

Interweaved with these crises are matters of poverty and the north-south divide - a tenfold reduction in resource consumption in industrialised countries is a necessary long-term target if adequate resources are to be released for developing countries.

Ten years on and seven years after the launch of Agenda 21, the joint United Nations and International Federation of Surveyors Bathurst Declaration on Land Administration for Sustainable Development (1999 and Williamson *et al*, 1999) found that the most serious problems facing the relationship between land and people included:

- degradation of land due to unsustainable land use practices;
- lack of land for suitable urban development;
- lack of security of tenure (which in many societies impacts most severely on women and children);
- inequitable access to land by indigenous peoples and minority groups;
- access to land by women;
- increasing vulnerability to disaster;
- destruction of bio-diversity;
- lack of adequate planning and of effective land administration;
- tensions between environmental conservation and development; and
- impact of market forces on traditional economies and tenures.

As the UNEP statistics gravely emphasise, the tensions are sharpening between human behavior and their worsening impact on the environment. This has profound implications for

the survival of future generations. It is this dynamic which starts to bring land administration and land management into closer and even overlapping proximity. If these systems do not respond and expand to meet the challenges of society's increasingly complex relationship with land, sustainable development will not move beyond rhetoric.

These tensions emphasise the need for complex and sophisticated decision-making which, in the context of economic reforms, means not only in government but the private sector and wider community. Civil society demands a place in the framework of decision-making. The WWW is just one example of the information revolution potential that exists to bring consultation and participation to a new level of effectiveness.

It is in this context that the next generation of land administration systems will have to be developed.

LAND ADMINISTRATION TRENDS

Ten years ago, a study of the World Bank's projects (Williamson 1991) saw a move away from sporadic physical infrastructure interventions to encompass broader infrastructure issues of greater impact for national economies and the productivity of cities. The major research topics identified in the then World Bank's Urban Development Division were:

- Municipal finance and management
- Urban infrastructure productivity and willingness to pay for urban services
- Housing markets and housing policy
- Housing finance institutions and policies
- Land management
- Urban environment policy

The World Bank's Development Report 1989 (World Bank 1989) recognised the importance of property rights as well as the lack of adequate systems in administering them.

> "The legal recognition of property rights - that is, rights of exclusive use and control over particular resources - gives owners incentives to use resources efficiently. Without the right to exclude others from their land, farmers do not have an incentive to plow, sow,

> weed and harvest. Without land tenure, they have no incentive to invest in irrigation or other improvements that would repay the investment over time. Efficiency can be further served by making property rights transferable." (p86)

> "In most countries real estate accounts for between half and three quarters of national wealth. If ownership is widely dispersed, tenure is secure, and title transfer is easy, real estate can be good collateral for nearly any type of lending. Unfortunately, these conditions are not always met in developing countries. Land distribution is often skewed, tenure (if any) insecure, and title transfer cumbersome. One key to a smoothly functioning system of land tenure is land registers supported by cadastral surveys. In many developing countries these are still woefully inadequate or missing altogether." (p87)

Over the last decade the focus of organisations such as the World Bank within land administration reform projects has been primarily on access to land, security of tenure and the operation of land markets. Simplistically the focus has been on individual land owners, not usually on a wider land administration infrastructure unless as a response to this narrower objective. While these projects may have also considered environmental and sustainable development issues, the reality is that the focus has been primarily on the economic dimension of land administration reform. This view is confirmed by a review influenced by rural sector policies by Deininger and Binswanger (1999) of:

> ...the evolution of policy recommendations concerning rural land issues since the formulation of the World Bank's "Land Reform Policy Paper" in 1975. That paper set out three guiding principles: the desirability of owner-operated family farms, the need for markets to permit land to be transferred to more productive users, and the importance of egalitarian asset distribution. In the 25 years since that paper was published, these guiding principles have remained the same, but it is now recognised that communal tenure systems can be more cost-effective than formal title, that titling programs should be judged on their equity as well as their efficiency, that the potential of land rental markets has often been severely underestimated, that land-sale markets enhance efficiency only if they are integra5ted into a broader effort developing rural factor markets, and that land reform is more likely to result in a reduction of poverty if it harnesses (rather than undermines) the operation of land markets and is implemented in a

decentralized fashion. Achieving land policies that incorporate these elements requires a cogent legal and institutional framework together with greater reliance on pilot programs to examine the applicability of interventions under local conditions."

The view is also confirmed by an overview of World Bank projects from an urban sector perspective by Galal and Razzaz (2000) in a World Bank paper titled "Reforming land and real estate markets".

The current focus of the World Bank is summarised by the President Mr Wolfenson in his address to the Board of Governors in Washington DC, September 28, 1999 when he stated "With poverty reduction front and centre of our agenda, our work at the rockface must be governance, institutions and capacity building". Issues concerned with property rights, security of tenure, access to land, land markets and land administration are central to this agenda.

As is the case in many developed countries, the focus of most land administration reforms in World Bank projects has been on either documenting or improving the administration of private rights. To a large extent this is because of the complexity in addressing national land administration reform, and as such the focus has not been on the development of national integrated land administration policies and infrastructures which incorporate both private as well as public rights. These projects have tended to exclude tenures concerned with common property, state lands, forest lands and other forms of property such as water rights from land administration reform projects. This focus on administering only private rights within national land administration systems has restricted those land administration systems addressing sustainable development objectives in an integrated manner at a state or national level. This is not a criticism of these projects since the economic driver has a high priority in developing countries and that it is only in recent years that the environmental and sustainable development priorities have gained greater momentum.

On the other hand, proposals for a more integrated and national approach to land administration should not come as a surprise, especially for developing countries. The reality is that many of todays developed countries went through a period of development not dissimilar to many of todays developing countries. Australia, Canada, the USA and New Zealand are good cases in point. In the early years of their development national integrated land

administration strategies based on an early form of spatial data infrastructure were central to government policy. Australian states (they were then separate colonies) usually had large Departments of Lands which were responsible for integrated colony-wide land administration policies for both private and public rights. These departments managed the development of comprehensive land administration infrastructures based on these spatial data infrastructures, showing all private and government lands, including reserves, forests etc. In the intervening years the need for these large government departments reduced as the tenure pattern stabilised and was fully documented. These early systems had a high priority as can be seen of the very senior position that Surveyors General held in those early days. It is only in the last decade or so that the importance of an integrated state or national land administration strategy, underpinned by a sophisticated spatial data infrastcucture, has again risen in part as a response to the information revolution but also due to the need to manage the land resource in a more integrated manner. Suffice to say that there is a very positive historical justification for an integrated approach to land administration systems in developing countries.

BRINGING LAND ADMINISTRATION AND SUSTAINABLE DEVELOPMENT CLOSER TOGETHER

The relationship between land administration and sustainable development is not universally accepted and many would say is unproven. This situation is similar to the relationship between land administration (and more particularly land titling of private rights) and the economic benefits of such initiatives two decades ago. Even though international instruments, such as AGENDA 21, recognise the importance of property rights and land administration to some degree in supporting sustainable development, the relationship is not quantified. In general national environmental or natural resource management policies rarely mention "land", "land administration" or "property rights" (see for example the www site for Environment Australia <http://www.environment.gov.au/>). The World Bank's Discussion Draft titled "Toward an Environment Strategy for the World Bank Group", April 2000 makes some mention of the role of land and property rights, albeit very briefly. Surprisingly it appears to recognise that these are central aspects of any environmental management implementation strategy but does not identify the role of land administration in environmental strategies. Relevant sections in the draft highlight this recognition and include:

- "...opportunities to empower the poor are clearly linked to equity issues such as property rights."

- "Natural resource management issues vary ... but there are some common concerns specifically related to property rights ..."
- "Inequity in land ownership ... jointly foster(s) inequity and unsustainable use.", and
- "... harness the role of markets ... to promote sustainable environmental management and investment."

The UN-FIG Bathurst Declaration on Land Administration for Sustainable Development (UN-FIG, 1999 and Williamson *et al*, 1999) which resulted from a Workshop and International Conference on Land tenure and Cadastral Infrastructures for Sustainable Development, did establish a strong linkage between land administration and sustainable development. Importantly this Declaration sets out evolving concepts and principles, which add to and build on a rich body of knowledge in land administration, and particularly cadastres, developed over more than half a century. This body of knowledge includes a wide range of journal articles, books, reports, statements, policies and declarations from international organisations such as the UN and the World Bank, from individual country governments, as well as from many individuals (Williamson, 2000).

The Bathurst Declaration concluded that "most land administration systems today are not adequate to cope with the increasingly complex range of rights, restrictions and responsibilities in relation to land, which are influenced by such factors as water, indigenous land use, noise and pollution" and "governmental information systems will have to continue their present trend to become increasingly open and public ... and governments have an important role as umpire, moderator and purveyor". In short, land information and land administration systems need to be re-engineered and to evolve to face the increasing complexity of the humankind-land relationship. Since many existing land administration systems are still based on a relatively narrow land administration paradigm centred on land registration and cadastral surveying and mapping, a new paradigm is required.

The Declaration acknowledged that the changing humankind-land relationship and society's priorities would require changes in land administration systems:

- to play a role in facilitating and supporting the complex decision making that is integral to sustainable development;

- to embrace the inter-relationship between good governance, civil society and land administration for sustainable development, and the need for accountability and benchmarking/performance indicators;
- to undertake legal, institutional and technological reforms to fulfil the call for inclusive decision-making and a holistic approach to land, water and other resource allocation/preservation issues;
- to ensure an inter-disciplinary approach to land administration and therefore the responsibility of nations to address the need for appropriate human resource development;
- to evolve beyond traditional cadastral paradigms to embrace fresh understanding of the relationship between land, property and rights and the need for initiatives like spatial decision-support systems and spatial data infrastructures;
- to respond creatively to differing needs and desires for tenure systems that could deliver equity, whether to specific disadvantaged groups within or between nations;
- to be expanded in order to provide information for land market activities, for public and private land management and for customary and informal tenures, in order to support sustainable development;
- to the laws concerned with information in the land registration system which may need to be adapted to current technological developments, for instance, in order to facilitate electronic conveyancing;
- to the statutory survey requirements on the location of pegs, boundaries and parcels to be adapted to more flexible circumstances depending on the character of the information and the use of the information for different purposes; and
- to be re-engineered to accommodate other forms of information, which may not be parcel-based.

The Executive Summary and the recommendations of the Bathurst Declaration are in Appendix 4 and 5.

RE-ENGINEERING LAND ADMINISTRATION SYSTEMS

Unfortunately much change in the broad land administration area in many countries focuses on technology and does not take a broad view of land administration reform as identified by Ting and

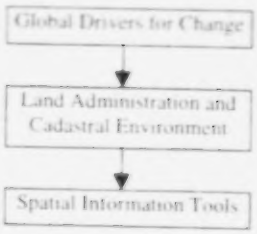

Figure 3. Hierarchy of Perspectives

Williamson (1999) and as discussed above. It is useful to consider three related perspectives in implementing change in land administration. First is an appreciation of the global drivers for change, which were mentioned previously. Next is an analysis of the impact of these drivers on the design of land administration systems, and particularly the cadastral component. This in turn identifies implementation issues with a focus on technical and administrative tools, which support these trends and developments, such as spatial data infrastructures and the Internet. All the changes proposed by the Bathurst Declaration can be categorised into these perspectives. The hierarchy of perspectives is shown

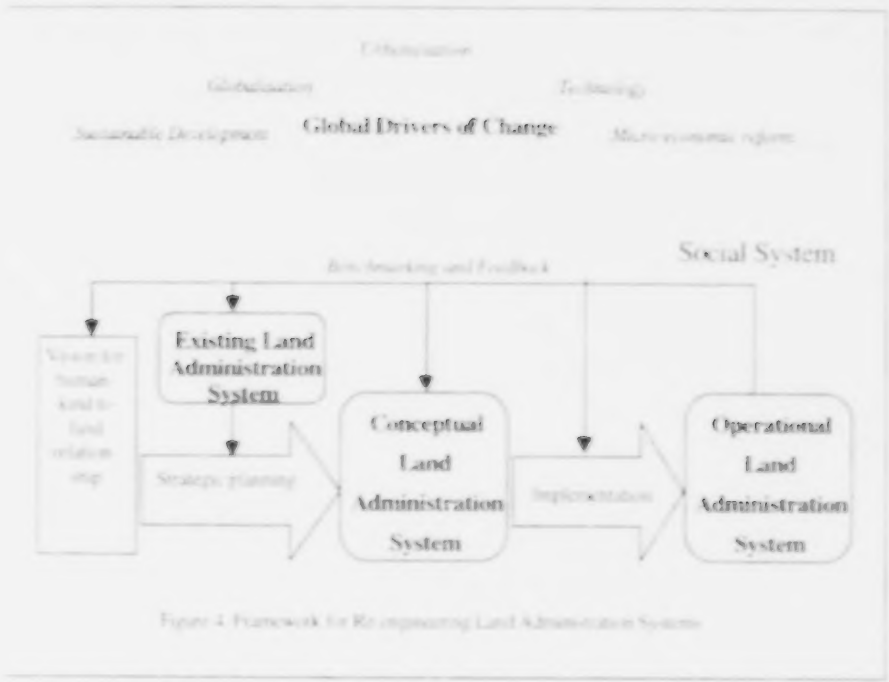

Figure 4: Framework for Re-engineering Land Administration Systems

in Figure 3. This hierarchy is expanded in the framework for re-engineering land administration systems in Figure 4 (Williamson and Ting, 1999).

In the framework in Figure 4, global drivers impact on the whole social system, which comprises the re-engineering process. The framework shows that through a strategic planning process (including the use of rigorous case study methodologies), the vision of a new humankind-land relationship, together with the existing land administration system, results in the development of a conceptual land administration system. Through an implementation process, an operational land administration system is developed based on a spatial data

infrastructure. Through benchmarking and feedback, the vision and conceptual system will be continually refined.

Some of the key implementation issues within the re-engineering process which are currently being researched by the author and his colleagues (see <http://www.sli.unimelb.edu.au/research/SDI_research/>) include:

1. the changing nature of spatial data infrastructures to recognise that SDIs are hierarchical systems based on inter- and intra-jurisdictional partnerships (Rajabifard et al, 1999, 2000a and 2000b). An understanding of the importance of partnerships in sharing land information and spatial data is just as important for developed as developing countries. Of particular importance is the integration of the key cadastral layer within the SDI. (Figure 5);

2. Recognising that SDIs are basic ***infrastructure***, like roads, railways and electricity distribution, which supports sustainable development, and in particular economic development, environmental and natural resource management, and social stability. Importantly it must be users or business systems which drive the development of SDIs (Figure 6) (after Chan and Williamson 1999). In turn the business systems which rely on the infrastructure in turn become infrastructure for successive business systems. As a result a complex arrangement of partnerships develops as the SDI develops. Increasingly governments are accepting that sustainable development is not possible without this basic ***land information infrastructure***.

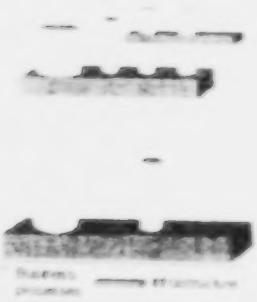

Figure 6
(Chan et al, 1999)

3. With the advent of spatial business systems demanding more from spatial data infrastructures and the broader land administration and cadastral systems, problems with the "spatial hierarchy" are becoming an issue. The spatial hierarchy problem refers to the difficulties in exchanging, aggregating and analysing different data sets based on non-coterminous boundaries (Eagelson et al, 2000).

Other research issues being addressed include:

4. the needs of evolving spatial decision support systems and SDIs,

5. the trend to establish national cadastral bases and street address files,
6. the impact of satellite positioning technologies on future SDIs,
7. the spatial dimension of native title,
8. the use of the WWW and other communication technologies, and
9. benchmarking processes and the development of performance indicators for land administration systems.

Two of the key steps in the re-engineering process, being the determination of the vision for the humankind-land relationship and the resulting conceptual land administration system, are discussed in more detail below.

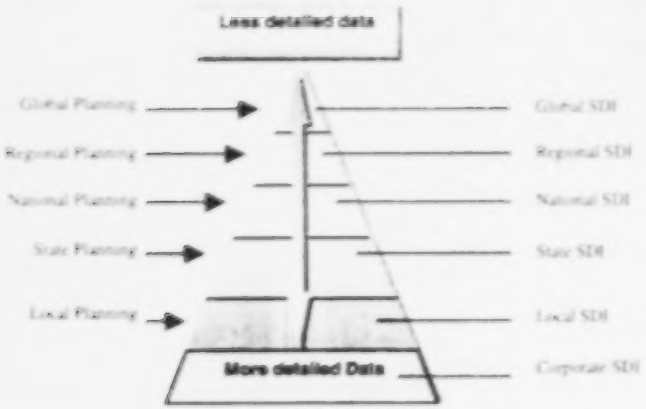

Figure 5
Relationships between data detail, different levels of SDIs, and level of planning
(Rajibafard *et al.* 1999)

THE NEED FOR A NATIONAL LAND ADMINISTRATION VISION

The development of a land administration vision for a country is an essential component of any re-engineering process. Land administration reform by its very nature is long term and as such there is a need for a clear road map to ensure that all developments and changes contribute to the overall vision for the land administration system for the country. Due to the complexity of land administration systems there is a strong argument for such projects to comprise "bite size" sub-projects which have a clear focus and often focus on administering one category of humankind to land (i.e. individual private rights), however it is desirable that

these sub-projects are undertaken as part of an agreed vision and global land administration strategy for the country.

Over the years a number of land administration or cadastral models or visions have been developed. Two of the most notable are described in the FIG Statement on the Cadastre (FIG, 1995) and the joint UN-FIG Bogor Declaration on Cadastral Reform (UN-FIG, 1996). Cadastre is defined in the Statement on the Cadastre as:

> "... normally a parcel based and up-to-date land information system containing a record of interests in land (e.g. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, and ownership or control of those interests, and often the value of the parcel and its improvements. It may be established for fiscal purposes (e.g. valuation and equitable taxation), legal purposes (conveyancing), to assist in the management of land and land use (e.g. for planning and other administrative purposes), and enables sustainable development and environmental protection."

The Bogor Declaration on Cadastral Reform expanded this definition to state that future cadastres would:

> "... develop modern cadastral infrastructures that facilitate efficient land and property markets, protect the land rights of all, and support long term sustainable development and land management." And to "... facilitate the planning and development of national cadastral infrastructures so that they may fully service the escalating needs of greatly increased urban populations. These will result from the rapid expansion of cities that is already taking place and which is projected to continue into the 21st century."

These visions, as well as the Bathurst Declaration, incorporated the concept of cadastral systems as *infrastructures* and highlighted the role of cadastres in the operation of land markets. While the Statement on the Cadastre was in reality a definition, the Bogor Declaration was more concerned with strategic and implementation issues, albeit in a relatively narrow cadastral sense.

Williamson (1996) developed a 10-year land information management vision for the State of Victoria, Australia to be a central component of any future land administration system. It built on his involvement with the development of the Statement on the Cadastre and the Bogor Declaration in addition to it receiving valuable input from many colleagues worldwide. This

vision took a more information systems view of modern land administration and cadastral systems as follows:

> "Simply within ten years all tiers of government, the private sector and the wider public will have controlled access to a standardised, complete, nation-wide, current, on-line land information system in real time, which is efficient, economically justified and compatible with other information systems."

A more recent investigation of future cadastral systems is the FIG Cadastre 2014 vision (Kaufmann, 1998 and Kaufmann and Steudler, 1998). This was commissioned in 1994 by one of the Working Groups of Commission 7 (Cadastre and Land Management) as a 20-year vision. The final report was the result of a four-year process involving input from many countries worldwide. Cadastre 2014 recognises the changing relationship of humankind to land, the changing role of governments in society, the impact of technology on cadastral reform, the changing role of surveyors in society and the growing role of the private sector in the operation of the cadastre. Cadastre 2014 has made a valuable contribution to the understanding of future cadastral systems. However it did by design restrict its focus to cadastral systems and emphasised technological changes.

These examples of land administration visions show a trend for future land administration and particularly cadastral systems to take a broader and more integrated view than in the past. It is highly desirable that the components of land registration, cadastral surveying and mapping, planning and land valuation, and their role in the operation of land markets, underpinned by a spatial data infrastructure, should be considered as one integrated system where the common objective is sustainable development. A result of taking such a broad integrated approach is that all rights, restrictions and responsibilities, often overlapping (including both 2 dimensional and 3-dimensional interests), relating to land, should be considered in designing and managing a land administration system, as shown schematically in Figure 7.

A key outcome of this review is the importance of a state or national spatial data infrastructure (SDI) as a key component of a broader or more integrated land administration infrastructure. Importantly the above approach includes many more interests than would traditionally be recorded in a cadastral or land registration system. This results in the multi-purpose cadastral concept which has been promoted for the last couple of decades but is only

becoming a reality in recent times (McLaughlin, 1975 and Panel on Multi-purpose Cadastre, 1983). Another outcome is the view that land administration is being viewed as an infrastructure to support sustainable development.

While these visions generally accept that there should be a range of different types of property rights maintained in a land administration system, such as private and public rights, common property, and leasehold, state and forestry interests, the visions require more detailed implementation strategies to be useful for specific countries.

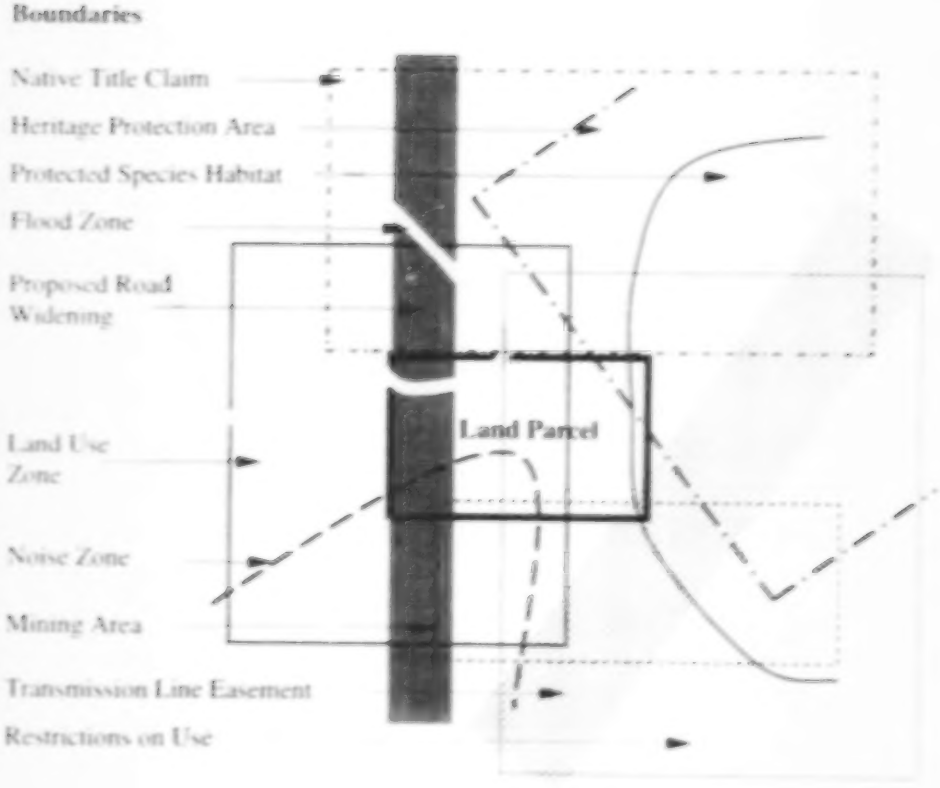

Figure 7
Schematic of overlapping rights, restrictions and responsibilities in a modern multi-purpose cadastre

IMPLEMENTATION STRATEGIES

In undertaking land administration reform it is important to consider the factors that drive or affect the reform and the choice of the specific strategies adopted. These factors are many and varied which re-enforces the statement that the land administration system for each country requires its own individual strategy. On the other hand strategies can be developed using the "tool box" approach. That is each specific strategy and resulting system can be made up of many separate, well-understood, generally proven and widely accepted components. For example systematic land titling may be an appropriate tool when individual private rights are well established, forms of communal tenures may be a more appropriate tool in formalising informal settlements or leasehold tenures many be a more appropriate tool in many rural areas (Williamson, 2000).

In designing a strategy, firstly it is important to recognise that almost every country will require ***a range of different strategies or tools depending on the relationship of humankind to land*** in each specific region in the specific country. In simple terms these arrangements include:

- Cities and urban areas, where active land markets operate on titled land or it is desirable that they operate.
- Cities and urban areas, occupied by informal settlements (squatter, illegal or low cost systems outside the formal or regulatory structures).
- High value agricultural lands which are titled and are part of the formal land market.
- Private untitled lands in cities, villages and rural areas where there is well established individual private ownership.
- Informal or illegal settlements in rural areas, especially in government forests.
- Lands which are subject to indigenous rights.
- Lands in all categories which are the subject of claims from previously dispossessed persons, and
- Government or state lands, reserves and forests and usually many other forms of common property

To some degree these categories are common to all developing (and many developed) countries.

The second consideration is that the relationship of humankind to land is dynamic with the result that there is ***an evolution in the each of these categories***. None of these relationships stay the same in the long term. They are affected by the impact of the global drivers on the relationship of humankind to land such as sustainable development, urbanisation, globalisation, economic reform and environmental management, as discussed above. As a result a different land administration response is required for each area or situation, within an overall national vision or strategy.

Third, the stage of development of the specific country has a major impact on the appropriate form of land administration response, and what is considered "best practice" for the individual country (Williamson, 2000). As an example, in simple terms in the Asian-Pacific area there are four general categories of countries:

- Developed countries, such as Japan, Korea, Australia, New Zealand and Singapore,
- Newly industrialised countries or countries in transition, such as Peoples Republic of China, Indonesia, Thailand, Malaysia and the Philippines,
- Countries at an early stage of development such as Vietnam, Cambodia and Laos, and
- Island states such as Fiji, Tonga and Vanuatu.

While each country has different development priorities, those in each group do share some similar priorities. A complication is that many countries do not fit easily into these categories with some countries having aspects of all categories. But in general the stage of development overall of an individual country does significantly influence the choice of which land administration strategies or tools are adopted.

The combination of all these factors determine or at least strongly influence, the specific strategy or strategies adopted in reforming or establishing the land administration system. These strategies draw on the land administration "tool box" for their institutional, legal, technical and administrative solutions.

For example there is a whole range of surveying and mapping technologies and approaches depending on what is the stage of development of the country and what is the major relationship of humankind to land which is being surveyed or mapped. These options include sporadic and systematic approaches, graphical and mathematical surveys, different positioning technologies such as satellite positioning or scaling off photomaps, different mapping technologies such as photomaps, topographic mapping and simple cadastral maps. The development of an appropriate national or state spatial data infrastructure is the key to developing an appropriate land administration infrastructure, which can support these different strategies and technologies.

In addition there is a range of options for the recording or determination of land tenure relationships. There are government guaranteed land titles, deeds registration systems, title insurance systems, qualified titles (both to boundaries and titles), individual ownership, leasehold and communal or customary tenures.

For all these arrangements there are a range of technologies which are again strongly influenced by the wealth and development of the country. For example whether titles or deeds and cadastral maps will be computerised or held as paper records or whether the Internet can be utilised to access land records.

Institutional arrangements are influenced by the same factors. Whether the system is decentralised, deconcentrated or centralised.

The level of education and training in a country is a major influencing factor. For example if a country such as Indonesia wished to have a land administration system supported by a land title and cadastral surveying system similar to Australia, this could possibly require 40,000 professional land surveyors and 30 or more university programs educating professional surveyors (based on Steudler *et al* 1997). Clearly this is not realistic in the short to medium term and as a result this re-enforces the need to develop appropriate solutions matched to the stage of development and specific requirements of the individual country.

Recognising all these constraints, Williamson (2000) argues there are a range of "best practices" or "tools" that are useful in undertaking the establishment or re-engineering of land administration systems under the headings of

- Land policy principles
- Land tenure principles
- Land administration and cadastral principles
- Institutional principles
- Spatial data infrastructure principles
- Technical principles
- Human resource development principles

CONCLUSION

This paper examines issues in re-engineering land administration systems to better meet future needs of society. The need for a vision, which incorporates sustainable development objectives and is based on a broader and more integrated approach utilising spatial data infrastructures, is argued. In order for countries or jurisdictions to work towards such a vision, a model for re-engineering land administration systems is discussed and a broad implementation strategy proposed.

The paper builds on the premise that the relationship between humankind and land in almost all societies is dynamic and influenced by global drivers, and that this dynamic relationship results in evolving land administration relationships. It also accepts that there is an increasing need for more complex and sophisticated decision-making world wide as a result of the sharpening tensions between human behavior and their worsening impact on the environment.

The paper then argues that most land administration projects undertaken by such organisations as the World Bank, have primarily focussed to date (almost by necessity) on issues of access to land, security of tenure and the operation of land markets. They have not usually considered the establishment of a wider national land administration infrastructure based on a national spatial data infrastructure, unless as a response to these narrower objectives. Their focus has primarily been economic as requested by the recipient countries.

While international and national environmental and sustainable development policies sometimes mention the importance of land and land administration in implementing their policies, mention is at best very limited. The result is that current land administration systems

are still structured around a 19th Century economic or land market paradigm and support the implementation of sustainable development objectives poorly, at best. As a result the paper calls for land administration systems to be re-engineered to better meet sustainable development objectives.

The importance of a clear national land administration vision is highlighted as is the need for a more detailed national land administration infrastructure which is able to serve the many different humankind to land relationships found in all countries.

The proposed implementation strategy has tried to highlight the complexity and inter-dependency of issues in land administration, cadastral systems, spatial data infrastructures and spatial information management. The strategy also highlights the multi-disciplinary nature of land administration systems. The paper has endeavored to show that any land administration strategy at any level of government must take a broader approach than in the past by recognising a wide range of social, economic and land related issues. A key outcome of such strategies is the development of appropriate national land administration infrastructures and spatial information management strategies conceived within a broad comprehensive vision.

The development of these strategies requires an understanding of the relationship between the changing humankind-land relationship, land administration policies, land administration systems, spatial business systems and spatial data infrastructures, while recognising the impact of technology across these dimensions (Figure 8). In this context, spatial data infrastructures will need to evolve to accommodate the business needs of land administration decision support systems and multi-purpose cadastres. An emphasis on business needs as distinct from infrastructure needs of spatial information will see a re-engineering of current SDIs as key components of future land administration systems.

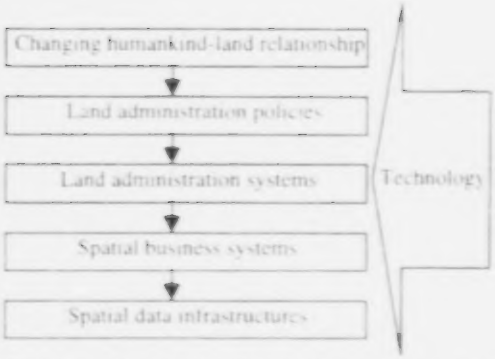

Figure 8. Developing land administration and spatial information management strategies

In summary, the paper proposes that sustainable development will be the focus for the land administration responses to the changing humankind-land relationship in the foreseeable future. This will demand sophisticated land administration infrastructures in order to support the necessary decision-making. These in turn will require support from more generic information technologies integrated with spatial information technologies that can process and package data that is of sufficient quality, accuracy, relevance and inter-operability to the decision-makers. Herein lies the challenge that needs to be tackled in developing the next generation of land administration systems.

RECOMMENDATIONS

Recognising the mission of United Nations Regional Cartographic Conferences (Appendix 1) is to address spatial data, cadastral issues and spatial data infrastructure issues while meeting sustainable development objectives, I recommend that this seventh UNRCC for the Americas should endorse the objectives, conclusions and recommendations of the joint UN-FIG Bathurst Declaration on Land Administration for Sustainable Development. A draft of this recommendation is included in Appendix 6.

Recognising the conclusions from the UN-FIG Bathurst Declaration and noting Resolution 4 from the 6th UNRCC for the Americas, 2-6 June, 1997, New York, USA on the role of the cadastre in spatial data infrastructures (Appendix 2) and Resolution 15 from the 14th UNRCC for Asia and the Pacific, 3-7 February, 1997, Bangkok, Thailand on linking cadastral mapping with topographic mapping within a wider spatial data infrastructure (Appendix 3), I recommend that the United Nations within available resources and with the expert assistance of the International Federation of Surveyors should organise a workshop and in cooperation with the Permanent Committee for Geospatial Infrastructure for the Americas to determine the role of land administration, and particularly the cadastre, in spatial data infrastructures in support of sustainable development objectives in the Americas and, in particular, to discuss technical, institutional and legal issues, problems and solutions concerned with integrating digital cadastral mapping with large-scale topographic mapping, within the context of wider national spatial data infrastructures.

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APPENDIX 1 – UNRCC Mission

The 6th United Nations Regional Cartographic Conference for the Americas, New York, U.S.A. (2-6 June 1997) re-affirmed the mission of UNRCCs (Resolution 1). Importantly it clearly highlights the importance of cadastre and the need to discuss and share information.

> *"the* ***mission*** *of the United Nations regional cartographic conferences is to provide both a regional and interregional forum for member States, through their governmental institutions, professional and academic sectors, non-governmental organisations and the private sector, to discuss and share information on related institutional, legal, economic and technical issues and to advise national Governments, the United Nations and other regional and international organisations on policy development options related to cartography, surveying, mapping, charting, cadastre, GIS technology and spatial data infrastructures in support of sustained economic growth for sustainable development and environmental management.*
>
> *Bearing in mind that the conferences address the requirements of mapping organisations, spatial data providers and related land information managers, who focus on the needs of national, regional and local decision makers, stakeholders and other end-users."*

APPENDIX 2 – Resolution from the 6th UNRCC for the Americas, 2-6 June, 1997, New York, USA

Resolution 4. The role of the cadastre in spatial data infrastructures

The Conference,

Bearing in mind *the conclusions of the United Nations Interregional Meeting of Cadastral Experts, held at Bogor, Indonesia, 18-22 March 1996, jointly sponsored by the United Nations and the International Federation of Surveyors, and the recommendations in the Bogor Declaration on cadastral reform,*

Recalling *the deliberations of the Sixth United Nations Regional Cartographic Conference for the Americas on the need better to understand and appreciate the relationship between land tenure and the physical environment,*

Mindful of *the outcomes of Agenda 21 which promoted the importance of efficient and accessible land markets based on cadastral systems and appropriate land tenure systems as key factors in support of sustainable development and environmental management,*

Recognising *the importance of efficient and effective cadastral systems in supporting the development of land markets, in providing security of tenure and access to land, in facilitating the provision of credit to farmers and peasants, and more generally in promoting economic development, social cohesion and sustainable development,*

Noting the benefit of *integrating cadastral/land tenure information with topographic information in providing an appropriate basis for the support of sustainable development and environmental management,*

Further noting *the difficulties being faced by many member States in integrating cadastral and topographic spatial data, especially in digital form,*

1. ***Recommends*** *that member States and appropriate stakeholders convene, through the proposed Permanent Committee on GIS Infrastructure for the Americas, and under the guidance and with the assistance of the Secretary-General of the United Nations, a special working group to determine the role of the cadastre in spatial data infrastructures and, in particular, to discuss technical, institutional and legal issues, problems and*

solutions concerned with integrating digital cadastral mapping with large-scale topographic mapping, within the context of wider national spatial data infrastructures;

2. ***Also recommends*** *that the deliberations and recommendations of the working group be reported to the Seventh United Nations Regional Cartographic Conference for the Americas;*

3. ***Further recommends*** *that the special working group review the Bogor Declaration on cadastral reform to assess its applicability to the Americas and, in particular, review the need for guidelines regarding:*

   a) *Cadastre and associated land administration along the lines of those guidelines recently produced for the Economic Commission for Europe;*

   b) *Costs, benefits, risks and value for money of cadastral systems in assisting member states in evaluation support for cadastral projects.*

APPENDIX 3 – Resolution from the 14th UNRCC for Asia and the Pacific, 3-7 February, 1997, Bangkok, Thailand

*15. **Linking cadastral mapping with topographic mapping within a wider spatial data infrastructure***

The conference,

Bearing in mind *the conclusions of the 1996 United Nations Interregional Meeting of Experts on Cadastre, jointly sponsored by the United Nations and the International Federation of surveyors, and the recommendations in the resulting Bogor Declaration, and the recommendations of the 1997 Third Meeting of the Permanent Committee on GIS Infrastructure for Asia and the Pacific,*

Mindful of the outcomes *of Agenda 21, which promoted the importance of efficient and accessible land markets based on cadastral systems and the establishment of appropriate land*

tenure systems, as key factors in support of sustainable development and environmental management.

Noting *the benefit of integrating cadastral and land tenure information with topographic information in providing an appropriate basis for supporting sustainable development and environmental management.*

Further noting *the difficulties being faced by many member States in integrating cadastral and topographic spatial data, especially in digital form.*

Recommends *that member States report to the next United Nations Regional Cartographic Conference on issues, problems and solutions concerned with integrating digital cadastral mapping with large-scale topographic mapping within the context of a wider national spatial data infrastructure.*

APPENDIX 4 - The UN-FIG Bathurst Declaration on Land Administration for Sustainable Development

Executive Summary

Almost all societies are currently undergoing rapid change brought about by a diverse range of factors that include growing population pressures on the land, especially in urban areas. The world's population has already reached six billion people. The poor are becoming increasingly concentrated in slums and squatter settlements in our ever-expanding cities. The gender inequities in access to economic and social opportunities are becoming more evident. Within 30 years, two thirds of the world's population will live in cities. Fresh water availability is now approaching crisis point. At present consumption levels, two-thirds of the world's population will live in water-stressed conditions by the year 2025. The challenge is not only to meet world population needs for food, shelter and quality of life, but also to ensure that future generations can also have their needs met.

Insecure property rights inhibit use and investment in rural and urban land. They hinder good governance and the emergence of engaged civil society. Uncoordinated development, poor

planning and management of land and its use, and the increasing vulnerability of populations to disaster and environmental degradation all compound the difficulties of meeting this challenge. Without effective access to property, economies are unable to progress and the goal of sustainable development cannot be realised.

The world is, however, changing. Growing awareness of the issues, better understanding of the consequences of actions, and greater capacity to secure and use relevant information are helping to bring about the necessary changes. These issues are forcing the re-engineering of land administration systems to ensure that they support sustainable development and efficient land markets. Land administration frameworks will be forced to respond rapidly to these unprecedented changes.

The joint United Nations and International Federation of Surveyors Bathurst Workshop[1] on Land Tenure and Cadastral Infrastructures for Sustainable Development has responded to this challenge. Land administration institutions and infrastructures will have to evolve and adapt their often inadequate and narrow focus to meet a wide range of new needs and technology, and a continually changing institutional environment. They also need to adapt continually to complex emerging humankind-land relationships at the same time as changing relationships between people and governments. These conditions should lead to improved systems of governance.

The Bathurst Workshop examined the major issues relevant to strengthening land policies, institutions and infrastructures and, in particular identified the following:

- future humankind/land relationships,
- the role of land in sustainable development,
- food, water and land policies,
- land tenure and land administration systems,
- how land markets, land registration, spatial planning and valuation interact, and
- re-engineering land administration systems.

For each of these key areas, the Workshop reviewed the existing situation within the rapidly changing land administration environment. It investigated and provided recommendations as

[1] Held in Bathurst, Australia from 18-22 October 1999.

to how land tenures, land administration institutions and infrastructures and cadastral systems should evolve to enable the challenges of change in the 21st century to be met.

The Bathurst Declaration on Land Administration for Sustainable Development calls for a commitment to providing effective legal security of tenure and access to property for all men and women, including indigenous peoples and those living in poverty or other disadvantaged groups. It identifies the need for the promotion of institutional reforms to facilitate sustainable development and for investing in the necessary land administration infrastructure. This gives people full and equal access to land-related economic opportunities.

Most significantly, the Declaration justifies and calls for a commitment on the part of the international community and governments to halve the number of people around the world who do not have effective access to secure property rights in land by the Year 2010.

To realise this commitment, the Workshop proposes a set of recommendations. The policy and institutional reform recommendations must ensure that there is a balanced and integrated approach to addressing all tenure relationships in both urban and rural society. Full and active participation by local communities in formulating and implementing the reforms is recommended. The need to develop land administration infrastructures that effectively address the constantly evolving requirements of the community is critical. Finally, information technology is seen as playing an increasingly important role in developing the necessary infrastructure and in providing effective citizen access to it.

Sustainable development is not attainable without sound land administration

APPENDIX 5 – The Bathurst Declaration Recommendations

Given that more than half the people in most developing countries currently do not have access to secure property rights in land and given the concerns about the sustainability of development around the globe and the growing urban crisis, the Bathurst Workshop *recommends* a global commitment to:

1. *Providing* effective legal security of tenure and access to property for all men and women, including indigenous peoples, those living in poverty and other disadvantaged groups;

2. *Promoting* the land administration reforms essential for sustainable development and facilitating full and equal access for men and women to land-related economic opportunities, such as credit and natural resources;

3. *Investing* in the necessary land administration infrastructure and in the dissemination of land information required to achieve these reforms;

4. *Halving* the number of people around the world who do not have effective access to secure property rights in land by the Year 2010.

The Workshop in confirming the Bogor Declaration, extending the professional debate on desirable land administration and recognising that the community of nations have committed themselves to the various United Nations Global Plans of Action arising out of the UN Summits over the last decade, *recommends* the following:

5. *Encourage* nations, international organisations, NGOs, policy makers, administrators and other interested parties to adopt and promote the *Bathurst Declaration* in support of sustainable development.

6. *Encourage* all those involved in land administration to recognise the relationships and inter-dependence between different aspects of land and property. In particular there is need for functional cooperation and coordination between surveying and mapping, the cadastre, valuation, physical planning, land reform, land consolidation and land registration institutions.

7. *Encourage* the flow of information relating to land and property between different government agencies and between these agencies and the public. Whilst access to data, its collection, custody and updating should be facilitated at a local level, the overall land information infrastructure should be recognised as belonging to a national uniform service to promote sharing within and between nations.

8. *Improve* security of tenure, access to land and to land administration systems through policy, institutional reforms and appropriate tools with special attention paid to gender, indigenous populations, the poor and other disadvantaged groups. In many nations, this will entail particular efforts in areas under customary or informal tenure and in urban areas where population growth is fast and deficiencies are most prevalent.

9. *Recognise* that good land administration can be achieved incrementally using relatively simple, inexpensive, user-driven systems that deliver what is most needed for sustainable development.

10. *Recognise* that the unacceptable rise in the incidents of violent dispute over property rights can be reduced through good land tenure institutions that are founded on quality land information data. Good land information underpins good governance. Where conflict arises, there must be inexpensive land dispute resolution mechanisms in place that are readily accessible to all parties concerned.

11. *Encourage* national and local government bodies to document and manage their own land and property assets.

12. *Recognise* that land markets operate within a range of land tenures of which freehold is but one. It is important to facilitate the efficient operation of land markets through appropriate regulatory frameworks that address environmental and social concerns.

13. In order to increase knowledge of the global situation of land administration and land tenure, the United Nations *undertake* a study of global land administration issues such as the range of tenure issues, gender, urban agglomeration, land disputes, problems and indicators with a view to producing a global atlas and related documentation. Much of the needed data are already available in different UN databases.

14. Recognising the difficulties in interpretation of the many land administration related terms, *develop* a readily accessible thesaurus, translated into appropriate languages, to facilitate a better understanding of the terminology used. Further, on the basis of selected criteria, use this to *prepare* examples of best practice in the field of land administration. This can be done using work already completed by FIG and FAO.

15. In view of the crucial importance of human resources in the management of land, *ensure* that there is sustained education and training in land administration. In particular, international agencies should seek to develop multi-disciplinary, multi-national training courses in land administration and make these available at the local level through the use of modern information technology.

16. International and national agencies, NGOs and other interested parties *to arrange* workshops and conduct studies with regard to such matters as the quality of access to land and information, gender issues, customary law and indigenous rights, land tenure systems, interaction between land and water rights, maritime cadastres, and the management of land administration systems.

17. In order to *coordinate* foreign assistance, countries seeking help should play a more active role in the coordination of aid and prepare a country profile analysis, describing the status of land administration and the need for improvements. Based on this the countries should then prepare a master plan to which all land administration, initiatives and projects should adhere.

18. In order to ensure sustainable development of territorial oceans claimed under UNCLOS, the United Nations *emphasise* the need for claimant countries to develop their capability to support effective marine resource administration through the national spatial data infrastructure.

19. *Undertake* analyses and develop performance indicators that can monitor the effectiveness of land administration and land tenure systems in relation to sustainable development and

20. That the Workshop and FIG strongly *support* the "Global Campaign for Secure Tenure" undertaken within the implementation of the Habitat Agenda, presently launched by the UNCHS (Habitat), and *commits* to promoting activities in terms of this campaign in future FIG programs.

APPENDIX 6 – Draft Resolution

1. The United Nations – International Federation of Surveyors Bathurst Declaration on Land Administration for Sustainable Development

The Conference,

Mindful of the growing population pressures on the land, especially in urban areas, that the poor are becoming increasingly concentrated in slums and squatter settlements in ever-expanding cities, that gender inequities in access to economic and social opportunities are becoming more evident and that fresh water availability is now approaching crisis point, the challenge is not only to meet world population needs for food, shelter and quality of life, but also to ensure that generations, yet unborn, can also have their needs met.

Noting that without effective access to property that it is difficult to address these issues, economies are unable to progress and the goal of sustainable development cannot be realised.

Recognising that insecure property rights inhibit use and investment in rural and urban land, and hinder good governance and the emergence of engaged civil society,

Further recognising the essential role that land administration and spatial data infrastructures play in supporting sustainable development,

Endorses the conclusions and recommendations of the United Nations-International Federation of Surveyors Bathurst Declaration on Land Administration for Sustainable Development.

And further endorses the call for a commitment from the international community to providing effective legal security of tenure and access to property for all men and women, including indigenous peoples and those living in poverty or other disadvantaged groups.

And more particularly endorses the recommendation which calls for a commitment on the part of the international community and governments to halve the number of people around the world who do not have effective access to secure property rights in land by the Year 2010.